CONTROL OF VENTILATION

Bradypnea and Tachypnea: Differential and Treatment

Intraoperative Learning · CA-1

THE QUESTION

Where the evidence disagrees

This topic was selected because an evidence synthesis beats a textbook on it: the trials disagree, or the guidance has moved recently.

THE EVIDENCE

What each source contributes, and how strong it is

Study design first — a cohort and a randomised trial do not carry the same weight.

Design	Year	Journal	What it found
Other	1998	Anesthesia and Analgesia	Volatile agents depress spontaneous ventilation dose-dependently and they do i
Other	2010	Anesthesiology	Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opi
Other	2016	Current Opinion in Anaesthesiology	Residual neuromuscular block has been reported in as many as 70 per cent of pa
Other	2017	British Journal of Anaesthesia	A train-of-four ratio of at least 0.9 became the accepted threshold for protec
Other	2015	Orphanet Journal of Rare Diseases	A rising respiratory rate in a spontaneously breathing patient is the body att
Other	1994	Anesthesiology	About 1.3 per cent of patients given a general anaesthetic had an unanticipate

6 resolved citations behind this deck; every point above traces to one of them.

IN PRACTICE

What the cohorts and reviews add

6 findings, each on the slide that follows.

ANESTHESIA AND ANALGESIA 1998

Volatile agents depress spontaneous ventilation dose-dependently and they do i

Volatile agents depress spontaneous ventilation dose-dependently and they do it mainly by shrinking the breath rather than slowing it - as desflurane…

ANESTHESIOLOGY 2010

Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opi

Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opioid treatments and still produces regular fatalities

CURRENT OPINION IN ANAESTHESIOLOGY 2016

Residual neuromuscular block has been reported in as many as 70 per cent of pa

Residual neuromuscular block has been reported in as many as 70 per cent of patients and it does more than weaken the diaphragm - it degrades…

BRITISH JOURNAL OF ANAESTHESIA 2017

A train-of-four ratio of at least 0.9 became the accepted threshold for protec

A train-of-four ratio of at least 0.9 became the accepted threshold for protecting the airway against aspiration before tracheal extubation

IN PRACTICE

Volatile agents depress spontaneous ventilation dose-dependently and they do i

Other · Anesthesia and Analgesia

Volatile agents depress spontaneous ventilation dose-dependently and they do it mainly by shrinking the breath rather than slowing it - as desflurane rose from 0.5 to 1.5 MAC in children, tidal volume and minute ventilation fell significantly and end-tidal carbon dioxide rose - so a normal-looking respiratory rate is not evidence of adequate ventilation.

Behforouz et al., Anesthesia and Analgesia 1998 · PMID 9806682

IN PRACTICE

Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opi

Other · Anesthesiology

Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opioid treatments and still produces regular fatalities, and naloxone is the only reversal available, which is why it is titrated to effect and then continued rather than given once and walked away from, since most opioids outlast a single dose of it.

Dahan et al., Anesthesiology 2010 · PMID 20010421

IN PRACTICE

Residual neuromuscular block has been reported in as many as 70 per cent of pa

Other · Current Opinion in Anaesthesiology

Residual neuromuscular block has been reported in as many as 70 per cent of patients and it does more than weaken the diaphragm - it degrades respiratory control itself and the pharyngeal coordination that keeps the upper airway open - so the fast shallow breathing of a partially reversed patient is an airway problem as much as a ventilation problem.

Fuchs-Buder et al., Current Opinion in Anaesthesiology 2016 · PMID 27755128

IN PRACTICE

A train-of-four ratio of at least 0.9 became the accepted threshold for protec

Other · British Journal of Anaesthesia

A train-of-four ratio of at least 0.9 became the accepted threshold for protecting the airway against aspiration before tracheal extubation, and reaching it is established by quantitative monitoring rather than by a head lift or a hand squeeze.

Hunter, British Journal of Anaesthesia 2017 · PMID 29161387

IN PRACTICE

A rising respiratory rate in a spontaneously breathing patient is the body att

Other · Orphanet Journal of Rare Diseases

A rising respiratory rate in a spontaneously breathing patient is the body attempting to clear carbon dioxide, and the finding that turns that from housekeeping into an emergency is end-tidal carbon dioxide that keeps climbing despite the increased minute ventilation - the early diagnostic clue to malignant hyperthermia.

Rosenberg et al., Orphanet Journal of Rare Diseases 2015 · PMID 26238698

IN PRACTICE

About 1.3 per cent of patients given a general anaesthetic had an unanticipate

Other · Anesthesiology

About 1.3 per cent of patients given a general anaesthetic had an unanticipated critical respiratory event in recovery - hypoxaemia, a respiratory rate below 8 or a carbon dioxide above 50 mmHg, or upper airway obstruction - and the anaesthetic risk factors were choices the anaesthetist had made, including opioid premedication, higher fentanyl doses and higher relaxant doses.

Rose et al., Anesthesiology 1994 · PMID 8053592

IN THE ROOM

What this changes about the next case

Colour is the strength of the evidence behind each step, not the urgency.

1. **1**
   Volatile agents depress spontaneous ventilation dose-dependently and they do it mainly by shrinking the breath rather than slowing it - as desflurane rose from 0.5 to 1.5 MAC in children, tidal volume and minute ventilation fell significantly and end-tidal carbon dioxide rose - so a normal-looking respiratory rate is not evidence of adequate ventilation.
2. **2**
   Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opioid treatments and still produces regular fatalities, and naloxone is the only reversal available, which is why it is titrated to effect and then continued rather than given once and walked away from, since most opioids outlast a single dose of it.
3. **3**
   Residual neuromuscular block has been reported in as many as 70 per cent of patients and it does more than weaken the diaphragm - it degrades respiratory control itself and the pharyngeal coordination that keeps the upper airway open - so the fast shallow breathing of a partially reversed patient is an airway problem as much as a ventilation problem.

4 **4**

A train-of-four ratio of at least 0.9 became the accepted threshold for protecting the airway against aspiration before tracheal extubation, and reaching it is established by quantitative monitoring rather than by a head lift or a hand squeeze.

5 **5**

A rising respiratory rate in a spontaneously breathing patient is the body attempting to clear carbon dioxide, and the finding that turns that from housekeeping into an emergency is end-tidal carbon dioxide that keeps climbing despite the increased minute ventilation - the early diagnostic clue to malignant hyperthermia.

KEY TAKEAWAYS

What to carry into the next case

> **Volatile agents depress spontaneous ventilation dose-dependently and they do i**
> Anesthesia and Analgesia 1998

> **Opioid-induced respiratory depression complicates 0.5 per cent or fewer of opi**
> Anesthesiology 2010

> **Residual neuromuscular block has been reported in as many as 70 per cent of pa**
> Current Opinion in Anaesthesiology 2016

> **A train-of-four ratio of at least 0.9 became the accepted threshold for protec**
> British Journal of Anaesthesia 2017

Respiratory rate is a poor stand-alone number - a normal rate can sit on top of a halved tidal volume and a saturation of 99 per cent can sit on top of a rising carbon dioxide - so read the rate together with the end-tidal carbon dioxide and the effort, and decide what the patient is trying to do before you decide what to give.

QUESTIONS I'LL ASK YOU IN THE ROOM

1. Her rate is 7 but the saturation is 99 per cent. Why does that not reassure me?
2. Give me four reasons a patient breathes fast in recovery, and tell me which one you can rule out from the end of the bed.
3. You suspect residual paralysis. What measurement, not what manoeuvre, would settle it?
4. When would you give naloxone here, how much, and what happens forty minutes later if you give it and walk away?

ORAL BOARDS STEM

> *A 71-year-old woman is breathing spontaneously through a laryngeal mask for a knee arthroscopy. Over ten minutes her respiratory rate falls from 16 to 7, the end-tidal carbon dioxide climbs from 42 to 58 mmHg, and the saturation stays at 99 per cent on 50 per cent oxygen. Twenty minutes later, in recovery, she is breathing 32 times a minute, using her accessory muscles, and saturating 91 per cent on a face mask. Take both halves in turn: what is the differential for the low rate, what is the differential for the high one, and what do you do about each?*

Respiratory rate is a poor stand-alone number - a normal rate can sit on top of a halved tidal volume and a saturation of 99 per cent can sit on top of a rising carbon dioxide - so read the rate together with the end-tidal carbon dioxide and the effort, and decide what the patient is trying to do before you decide what to give.

SOURCES

[1] Behforouz et al., Anesthesia and Analgesia 1998 · PMID 9806682
[2] Dahan et al., Anesthesiology 2010 · PMID 20010421
[3] Fuchs-Buder et al., Current Opinion in Anaesthesiology 2016 · PMID 27755128
[4] Hunter, British Journal of Anaesthesia 2017 · PMID 29161387
[5] Rosenberg et al., Orphanet Journal of Rare Diseases 2015 · PMID 26238698
[6] Rose et al., Anesthesiology 1994 · PMID 8053592